Compact Object Problem set
Dr. Koji Mukai
Date Due: February 22, 2001

Homework Questions

These homework questions are meant to reinforce the relevant scales of size, time, and energy of white dwarfs and neutron stars. For the purpose of these questions, you can ignore all relativistic corrections (i.e., use the formulae from Newtonian mechanics), even though for neutron stars they are important.

1. Derive the breakup spin period of

   (a) the Sun (assume a mass of $1 M_\odot = 2 \times 10^{33}$ g and a radius of 700,000 km).

   (b) A white dwarf of 0.6 $M_\odot$ (assume a radius of 9000 km).

   (c) A neutron star of 1.4 $M_\odot$ (assume 10 km radius).

   For all three, assume a spherical body with no rotation-induced flattening.

2. Assume that the moment of inertia of neutron stars and white dwarfs can be approximated by that of a uniform sphere of the same mass and radius.

   (a) Take a 1.4 $M_\odot$, 10 km radius neutron star with a spin period of 0.1 s. What is its total rotational energy? If it also has $\dot{P} = -1.0 \times 10^{-12}$ s s^{-1}, what is the total luminosity available from this spin-down?

   (b) Reapeat the calculation for a 0.6 $M_\odot$, 9000 km radius white dwarf with a 100 s spin period and $\dot{P} = -1.0 \times 10^{-14}$ s s^{-1}.

The answers are due on 2001 February 22nd.